



A

PATENT

ATTORNEY DOCKET N°: 38292R1  
EXPRESS MAIL LABEL N°: EL 025 200 855 US

**NONPROVISIONAL PATENT APPLICATION TRANSMITTAL LETTER**

BOX PATENT APPLICATION  
ASSISTANT COMMISSIONER FOR PATENTS  
WASHINGTON DC 20231

Transmitted herewith for filing is the patent application of:

INVENTOR(S): LEO JOHN WILZ  
1718 Hamer Drive, N.W.  
Cedar Rapids, IA 52405  
Linn County  
Citizen of the United States

Title: **IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER  
HAVING DIVERSITY ARCHITECTURE**

---

**CERTIFICATION UNDER 37 C.F.R. §1.10**

I hereby certify that this Nonprovisional Application Transmittal and the documents referred to as enclosed therein are being deposited with the United States Postal Service on this date, April 16, 1998 in an envelope as "Express Mail Post Office to Addressee", Mailing Label N° EL 025 200 855 US addressed to: Box Patent Application, Assistant Commissioner for Patents, US PTO, Washington, D.C. 20231.

*Lora Frecks*

Lora M. Frecks

DATED: April 16, 1998

**CLAIM FOR BENEFIT OF EARLIER  
APPLICATIONS UNDER 35 U.S.C. § 119(e)**

<u>USSN</u>	<u>Filing Date</u>	<u>Inventor(s)</u>	<u>Status</u>
60/044,249	04/23/97	Wilz	Provisional



Please direct all correspondence to:

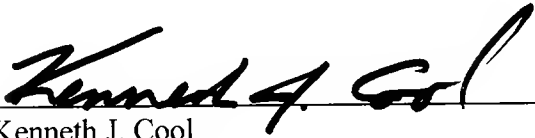
SEAN PATRICK SUITER  
SUITER & ASSOCIATES, PC  
11516 Nicholas Street, Suite 205  
Omaha, NE 68154-4409  
(402) 496-0300 (Telephone)  
(402) 496-0333 (Facsimile)

DATED: April 16, 1998.

Respectfully submitted,

Leo John Wilz,

INTERMEC TECHNOLOGIES CORP.,

By   
Kenneth J. Cool  
Reg. N° 40,570

**END OF DOCUMENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR PATENT

ON

IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER HAVING  
DIVERSITY ARCHITECTURE

# IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER HAVING DIVERSITY ARCHITECTURE

## 5                    CROSS-REFERENCE TO RELATED APPLICATION

The present application claims the benefit under 35 U.S.C. § 119(e) to provisional application Serial No. 60/044,249 filed April 23, 1997. Said provisional application Serial No. 60/044,249 is hereby incorporated by reference in its entirety.

10

## BACKGROUND OF THE INVENTION

The present invention generally relates to the field of wireless communications, and more particularly to a transceiver having improved receiver architecture.

15            There are many applications in which it is desirable to be able to provide wireless communications. For example, in an industrial warehouse environment individual roaming workers may utilize portable data terminals for inventory tracking and accounting purposes. The warehouse worker must be mobile, having the freedom of movement  
20 throughout any position in the warehouse to reach the product location, yet remain in constant communication with a central or host computer over a local network. In such an application, it is desirable for the mobile data terminal to communicate with the host computer over the central network via wireless communications, for example by using a  
25 radio-frequency transceiver. Thus, an interface device, or access point, may be utilized to serve as an interface between a wireless and a directly linked communication network.

It is often desirable for a network interface device to utilize several forms of communications media. For example, it may be desirable to

provide an access point interface to utilize two individual radio-frequency transceivers for providing communications at two different frequencies simultaneously. Such a transceiver may transmit on a first frequency and receive on a second frequency in order to provide full duplex  
5 communications, avoid interference, etc.

A communication transceiver typically requires or preferably utilizes duplex communications wherein information is both transmitted and received by a single unit transceiver unit and wherein the transmitter apparatus and receiver apparatus of the transceiver share  
10 common hardware and resources. In such a transceiver, selection between the transmitter and receiver is implemented via switching and electronic enabling of the required hardware devices. However, because of the loading and cross talk effects caused by the sharing of common hardware and from the use of switches, increased noise may be  
15 introduced into the communication signal, the signal-to-noise ratio may decreased and the noise figure of the signal may be increased correspondingly. Lower signal-to-noise ratios adversely affect maximum transmission ranges and increased noise figures result in an increase in transmission error rates because of maximum power limits mandated by  
20 government regulations and other design constraints.

### SUMMARY OF THE INVENTION

Accordingly, it is a goal of this invention to provide a method and apparatus for improving the signal-to-noise ratio and reducing the noise  
25 figure of a wireless communications transceiver which utilizes dual transceiver and receiver architecture wherein multiple or diversity architecture may be utilized.

The transceiver architecture of the present invention may be utilized in a base station transceiver or a mobile transceiver unit of a

mobile radio data communication system, or in similar devices and systems, as disclosed in U.S. Patent No. 5,483,767 issued January 9, 1996, said U.S. patent being assigned to the entity to whom the present invention and application are subject to obligation of assignment. Said  
5 U.S. Patent No. 5,483,767 is hereby incorporated by reference herein in its entirety.

The transceiver architecture of the present invention may be utilized in a data transceiver module for digital communications such as a spread spectrum transceiver module utilizing multiple mode  
10 transmission as disclosed in PCT Publication No. WO 96/38925 published December 5, 1996, said PCT publication being assigned to the entity to whom the present invention and application are subject to obligation of assignment.

It is to be understood that both the foregoing general description  
15 and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed.

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and together with the general description, serve to explain the  
20 principles of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The numerous objects and advantages of the present invention may be better understood by those skilled in the art by reference to the  
25 accompanying figures in which:

FIG. 1 is an illustration of a multilevel communications system in accordance with the present invention;

FIG. 2 is an illustration of a communications system of the present invention, further showing a hybrid wireless and direct link communications system;

FIG. 3 is an illustration of a network access node of a communications system in accordance of the present invention, further showing the implementation of dual wireless communications transceivers;

FIG. 4 is an illustration of an alternative configuration of the communication system of FIG. 3;

FIG. 5 is an illustration of a communication system of the present invention, further showing a diversity architecture transceiver;

FIG. 6 is an illustration of standard architecture for implementing a diversity architecture transceiver in accordance with the present invention;

FIG. 7 is an illustration of improved architecture for implementing a diversity architecture transceiver in accordance with the present invention;

FIG. 8 is an illustration of an alternative transceiver architecture of the present invention having improved receiver sensitivity and interference rejection; and

FIG. 9 is an illustration of multiple access points utilizing communication transceivers of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the presently preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.

Referring now to FIG. 1, a multilevel communications system in accordance with the present invention is shown. The multileveled

communication system **10** typically comprises a central host computer ("HOST COMPUTER") **12** functioning as a main sever for performing computationally intensive and time consuming processing tasks, centralized mass storage functions, network management and control tasks and the like, etc. The central host computer **12** may be any of a variety of commercially available central computers or servers, for example a VAX mainframe or Alpha Server available from Digital Corporation, an AS/400, RS/6000 or S/390 server available from IBM Corporation, or the like kind of server. The central computer **12** hosts, implements and controls a centralized local network ("NETWORK") **14** for providing a linkage between several communication channels. A plurality of network access points ("ACCESS POINT") **16**, **18** and **20** may be connected to the network **14**, each providing an access node to the host computer **10** through the network **14**.

Each of the network access points may be capable of functioning as a point of access for individual computer terminals ("TERMINAL"). For example, access point **16** may provide network interfacing functions for terminals **22**, **24** and **26**; access point **18** may provide network interfacing functions for terminals **28**, **30** and **32**; and access point **20** may provide network interfacing functions for terminals **34**, **36** and **38**.

The network **14** as illustrated in FIG. 1 and as referred to herein preferably refers to any type of widely utilized local area network (LAN) and may be equally applicable to any type of widely utilized wide area network (WAN). Such network may be, for example, a type of network referred to as "Ethernet" which operates according to standards promulgated by the Institute of Electrical and Electronics Engineers (IEEE) such as any IEEE 802.3 standard. Further, any IEEE promulgated network standard may be utilized. For example, the network **14** may be a commonly utilized 10Base-T, 10Base-2 or 10Base-

5 Ethernet having data transmission rates on the order of 10 megabits per second (10-Mbps). Alternatively, the network **14** may be a Fast Ethernet, or 100Base-T, network having data transmission rates on the order of 100 megabits per second (100-Mbps). The network **14** may preferably be a Gigabit Ethernet network having data transmission rates on the order of one gigabit per second (1-Gbps) according to the Gigabit Ethernet Standard IEEE 802.3z as the standard becomes widely utilized. The network may further implement other types of available network protocols or standards as well, such as the CSMA/CD protocol, Token  
10 Ring, FDDI, ATM, Fibre Channel, and other common network protocols, for example.

The network **14** may be compatible with widely utilized operating systems and applications, including upper layer protocol stacks such as TCP/IP, IPX, Netbui, DECnet, and others, for example. Other emerging  
15 new network standards may be utilized with network **14** as well, such as IEEE 802.1q or IEEE 802.1p for providing VLAN and explicit priority information for packets in the network. Further, other advanced signal processing techniques may be incorporated with the network **14** such as data compression to improve the effective bandwidth over the bandwidth  
20 fixed by physical limitations, for example MPEG-2 compression. Full-duplex operating modes for switch-to-switch and switch-to-end station connections are supported by network **14**, including support for half-duplex operating modes if necessary for shared connections, such as when using repeaters or the CSMA/CD access method. The network **14**  
25 preferably utilizes fiber optic hardwire direct connections, but may also support Category 5 unshielded twisted-pair (UTP) or coaxial transmission lines.

Referring now to FIG. 2, a communications system of the present invention is shown, illustrating a hybrid wireless and direct link

communications system. The communications system **40** may utilize a central host computer ("HOST") **42** and network ("NETWORK") **44** substantially similar to the host computer **12** and network **14** of FIG. 1. One or more access points may be utilized to provide multiple modes of access to the computer network **44**. Access points or servers ("WIRELESS-DIRECT LINK") **46**, **48** and **50** may provide an interface between a wired communications system **70** and a wireless communications system **72**. Each of the access points **46**, **48** and **50** for providing a wireless-to-direct system link may utilize a transceiver having diversity architecture in accordance with the present invention for communicating with mobile data terminals ("MOBILE TERMINAL") **52** and **54** which may be similarly equipped. Mobile terminals **52** and **54** may communicate over the network **44** by linking to the network through access points **46**, **48** and **50** via communication links **74**, **76**, **78** and **80**. Communication links **74**, **76**, **78** and **80** are preferably radio-frequency communication links. The overall effective roaming range of the mobile terminals **52** and **54** may be extended by utilization of an intermediate access point ("WIRELESS-WIRELESS LINK") **56** which provides a wireless-to-wireless communications link to the network **44**. The mobile terminals **52** and **54** may communicate with the intermediate access point **56** via wireless communication links **82** and **84**, respectively, which in turn communicates with a wireless-to-direct access point **48** via wireless communication link **86**, which in turn directly communicates over the network **44**.

The access points are preferably NORAND 6710 access points available from NORAND Corporation of Cedar Rapids, Iowa. The access points preferably operate with AMD 29200 RISC processors to implement a real-time multitasking operating system for servicing the radio, or wireless, network and the direct connection network (e.g., Ethernet). The

access points may be managed by Simple Network Management Protocol (SNMP) version one (SNMPv1) or version two (SNMPv2) or the Common Management Information Protocol (CMIP) to allow configuration and access to network configurations such as the NORAND Enterprise Management Information Base. The access points may further include two PC Card (a.k.a. PCMCIA) version 2.0 or higher slots for accommodating Type II or Type III PC cards. The access points are preferably compatible with WLI Forum compatible devices. Structurally, the access points may comprise a housing meeting the NEMA Standard ICS-110, for example NEMA 4 which is watertight and dust-tight for indoor applications for protecting the access point equipment against splashing water, water seepage, falling water, hose-directed water and severe external water condensation. Alternatively, the housing of the access point may comprise an Intrinsically-Safe enclosure.

Mobile terminal **52** may be temporarily stationed in a terminal dock ("TERMINAL DOCK") **58** which may be directly linked to network **44**, for example to provide batch type data transfer when not in use or when the wireless system **72** is shut down or not available. Further, mobile terminal **52** may be docked in terminal dock **64** so that the terminal may operate and communicate with peripheral device ("PERIPHERAL DEVICE") **62**. Peripheral device **62** may be a printer, an independent computer, a battery charging power source, a vehicle, a workstation, etc. Additionally, terminal dock **64** and peripheral device **62** may be incorporated into a single physical unit such as a mobile printer having a terminal receiving receptacle and appropriate communications facilities. A peripheral device **66** similar to peripheral device **62** may be connected to intermediate access point **56** wherein mobile terminal **54** operates and communicates with peripheral device **66** via communication link **84**.

Mobile terminal **54** may operate and communicate with peripheral device **68** via communication link **88**. Peripheral device **68** may be a device similar to peripheral devices **62** and **66**. Further, communication link **88** may one of several differing types of wireless links. For example, wireless link **88** may utilize infrared communications for providing a low power, short hop communication link. Alternatively, communication link **88** may be an optical link, or may be a radio-frequency link. Further, any of the wireless communications links **74, 76, 78, 80, 82, 84, 86** or **88** may implement one or more types of remote communications such as infrared, optical, radio-frequency, sonic, ultrasonic, magnetic, etc.

The wired communications system **70** and the wireless communications system **72** may utilize the NORAND Open Wireless LAN Network Management Application for providing network management functions. The network management platform may further incorporate HP OpenView for WINDOWS and NodeManager for HP-UX available from Hewlett-Packard Corporation (WINDOWS being a trademark of Microsoft Corporation).

Referring now to FIG. 3, a network access node of a communications system in accordance with the present invention is shown, illustrating the utilization of dual wireless communications transceivers. The communications system **90** of FIG. 3 may comprise a direct link communications system **120** and a wireless link communications system **122**. The direct link communications system **120** may include a central host computer ("HOST") **92** implementing a computer network ("NETWORK") **94** substantially similar to networks **14** and **44** shown in FIGS. 1 and 2. Access point **96** communicates directly with the network **94** and may invariably utilize controller ("CONTROLLER") **98** for implementing the network interfacing functions. The access point **96** may also include dual transceivers

("TRANSCIVER") **100** and **102** being ultimately connected to controller **98**. The transceivers **100** and **102** may utilize wireless communications for operating over communications links **116** and **118**. Transceivers **100** and **102** may utilize antennas **104** and **106**, respectively, in the case  
5 where communications links **116** and **118** are radio-frequency communications links. In such a case, mobile terminals ("TERMINAL") **108** and **110** utilize antennas **112** and **114**, respectively and of like kind, for radio-frequency communications over communications links **116** and **118**.

10 Dual transceivers **100** and **102** may be utilized in a single access point **96** for varying purposes. For example, a first transceiver **100** may be utilized to communicate with the network at a first level of security and access in which only terminal **108** is allowed to communicate with transceiver **100**. The operator of terminal **108** may have a higher level of  
15 access to the network **94** for performing administrative, supervisory, accounting, or programming type activities which may not be available to all terminal operators and which may be accessible only through transceiver **100** via link **116**. The operator of terminal **110** may be provided with a lower level of access to network **94** and therefore may  
20 communicate only with transceiver **102** via link **118**. Alternatively, multiple transceivers operating at different frequencies may be utilized in a single access point **96** to increase the number of usable channels and therefore the number of terminals operating in a single location. For example, transceiver **100** may accommodate up to 24 terminals and  
25 transceiver **102** may accommodate an additional 24 terminals for allowing the operation of a total of 48 terminals on the communication system **90**.

The transceivers of FIG. 3 may operate on available frequencies unregulated or made widely available for commercial use by government

agencies. For example, transceiver **100** may be a 2.4 GHz RangeLAN2 radio while transceiver **102** may be a Norand 900 MHz radio wherein both radios may be utilized simultaneously. The transceivers **100** and **102** may be PC card (a.k.a. PCMCIA) form factor radio cards conforming to PC Card standard version 2.0 or higher, for example. The transceivers **100** and **102** may be either WLI Forum or IEEE 802.11 compatible radios.

Referring now to FIG. 4, an alternative configuration of the communication system of FIG. 3 is shown. The network **124** may comprise a host computer ("HOST") **126** implementing a computer network ("NETWORK") **128**. An access point **130** may communicate with the direct link communications system **160** via a controller ("CONTROLLER") **132** operationally connected to the network **128**. The access point **130** utilizes a transmitter ("TRANSMITTER") **134** and a receiver ("RECEIVER") **136**, which are ultimately connected to controller **132** for communicating over wireless communications system **158**. The transmitter **134** may be a dedicated transmitter for performing communications transmissions to mobile terminals ("TERMINAL") **142** and **144** via communications links **150** and **152**. Conversely, receiver **136** may be a dedicated receiver for receiving data communications from mobile terminals **142** and **144** via communications links **154** and **156**. In the instance in which communications links **150**, **152**, **154** and **156** are radio-frequency links, antennas **138**, **140**, **146** and **148** may be utilized by transmitter **134**, receiver **136**, terminal **142** and terminal **148** respectively.

Access point **130** may utilize a dedicated transmitter **134** and a dedicated receiver **136** for varying purposes. For example, the hardware of the transceiver **134** may be optimized for data transmissions whereas the hardware of the receiver **136** may be optimized for data receptions,

which may require different hardware designs. Other inherent advantages may be further realized. For example, isolation of the output stages of the transmitter **134** from the input stages of the receiver **136** will prevent noise in the output of the transmitter **134** from being introduced onto the received communications signal and inadvertently amplified by the input stages of the receiver **136**. Additionally, full duplex transmissions and true multitasking operations may be implemented such that access point **130** may simultaneously upload and download data to terminals **142** and **144**.

Referring now to FIG. 5, a communication system of the present invention is shown utilizing a transceiver having diversity architecture. The communications system **162** may comprise a host computer ("HOST") **164** implementing a computer network ("NETWORK") **166**. Access point **168** communicates with the network via controller **170** via direct link communications system **188**. Access point **168** utilizes a diversity architecture transceiver **172** in accordance with the present invention, the diversity architecture transceiver being ultimately connected to controller ("CONTROLLER") **170**. The diversity architecture transceiver ("TRANSCIVER") **172** may utilize two antennas **174** and **176** which may be integrated as a dual antenna. The diversity architecture transceiver **172** communicates with mobile terminal ("TERMINAL") **178** via wireless communications links **182** and **184** wherein terminal **178** utilizes an antenna **180** of like kind to antennas **174** and **176** when communications links **182** and **184** are radio-frequency communications links. Access point **168** may utilize one or more diversity architecture transceivers **172** for any one or more varying purposes, including reasons set forth in the description to FIGS. 1-4.

Referring now to FIG. 6, standard architecture is shown for implementing a transceiver having diversity architecture. The standard

transceiver **190** may utilize first and second antennas **192** and **194** being connected to a single pole, double throw (SPDT) switch **196** for selection of one antenna or the other. The switch **196** feeds into a bandpass filter **198** which in turn feeds into the transceiver hardware

5 **200**. At the input of the transceiver hardware, the bandpass filter feeds into a single pole, double throw switch **202** which is used to select between receiver front end hardware **204** and transmitter back end hardware **206**. When the switch **202** is set to select receiver hardware **204**, the output of the bandpass filter **198**, after being received by the

10 selected one of the two antennas **192** and **194** with switch **196** and after passing through bandpass filter **198**, feeds into a low noise input amplifier ("LNA") **208** which in turn feeds into mixer **210**. The mixer **210** combines received input signals with the output of a receiver local oscillator ("LO") **212** to provide a receiver data signal ("RxD") **214**. When

15 switch **202** is set to select transmitter back end hardware **206**, a transmit data signal ("TxD") **216** is combined with the output of a transmitter local oscillator **218** using mixer **220**. The output of mixer **220** feeds into a transmitter power amplifier ("PA") **222**, the output of which feeds into the selected antenna **192** or **194** via switch **196** after

20 being fed through filter **198**.

Referring now to FIG. 7, improved architecture for implementing a transceiver having diversity architecture in accordance with the present invention is shown. The diversity architecture transceiver **224** may utilize multiple antennas **226** and **228** as discussed, *supra*. A first

25 antenna **226** maybe utilized to receive a radio-frequency signal. The signal received by antenna **226** may be bandpass filtered by filter **230**, the output of which is fed into the transceiver hardware **234**. Within the transceiver hardware **234**, the output of the bandpass filter may be fed into a low noise amplifier ("LNA") **238**.

A second antenna **228** may be further utilized which is capable of being used for receiving and transmitting purposes. Antenna **228** connects to bandpass filter **232** to filter out signals lying outside of the pass band frequency range for either transmitted or received signals.

- 5 Bandpass filter **232** connects to a single pole, double throw switch **236** within the transceiver hardware **234**. Switch **236** selects between receiving functions **254** and transmitting functions to be performed using antenna **228**. When switch **236** is set to select receiving functions **254**, bandpass filter **232** feeds into a low noise amplifier ("LNA") **240**.
- 10 When switch **236** is set to select transmitting functions **256**, a transmitting power amplifier ("PA") **242** is selected for the transmitter output signal path.

- Within the transceiver hardware **234**, a single pole, triple throw switch **244** selects between receiving signals via antenna **226**, receiving
- 15 signals via antenna **228**, or transmitting signals via antenna **228**. Switch **246** connects to low pass filter **246** which in turn connects to mixer **248** for combining received signals with the output of a local oscillator **250** to produce intermediate frequency signals **252**, and vice versa for transmitted signals.

- 20 It has been discovered that the transceiver having diversity architecture of FIG. 7 provides at least a two decibel improvement in the transceiver noise figure resulting from effectively placing switch **196** of FIG. 6 after the low noise amplifiers as illustrated in FIG. 7. Further, enable signals ("EN") **258**, **260** and **262** may be provided to amplifiers
- 25 **238**, **240** and **242**, respectively, to turn off the amplifiers when not in use so as to not introduce any interfering noise in the activated amplifiers.

Referring now to FIG. 8, an alternative transceiver architecture of the present invention is shown having improved receiver sensitivity and

interference rejection. Transceiver **264** may utilize multiple antennas **266** and **268** for reasons as set forth, *supra*. A first antenna **266** may be utilized for receiving input signals and may feed directly into a low noise amplifier ("LNA") **270**. Amplifier **270** may operate in the open loop mode, or may operate in the closed loop mode as shown by feedback loop **272** in dashed lines. Switching between open loop and closed loop modes for amplifier **270** may be accomplished via a single pole, single throw (SPST) switch **274** in feedback loop **272**.

The output of amplifier **270** preferably feeds into a single pole, double throw switch **276** which may be utilized to select between the utilization of antennas **266** or **268** for signal receiving purposes. Switch **276** connects to bandpass filter **278** which in turn feeds into a low noise amplifier ("LNA") **280**. The output of amplifier **280** feeds into mixer **282** where received signals are combined with local oscillator **284** to produce intermediate frequency signals **286**.

Antenna **268** may be utilized for either receiving or transmitting signals. Antenna **268** connects to low pass filter **288** which in turn connects to a single pole, double throw switch **290**. Switch **290** may be utilized to selectively connect antenna **268** to receiver hardware **300** or transmitter hardware **302**. When switch **290** is set to select receiver hardware **300**, switch **290** connects antenna **268** through filter **288** to switch **276**. When switch **290** is set to select transmitter hardware **302**, switch **290** connects to the output of transmitter power amplifier ("PA") **292**. Power amplifier **292** receives the output of mixer **294** which combines intermediate frequency signals with the output of a transmitter local oscillator ("LO") **296**.

It has been discovered that better receiver sensitivity over the standard transceiver design, such as shown in FIG. 6, through antenna **266** may be attained by the diversity architecture of FIG. 8. Further, the

architecture of FIG. 8 provides better interference rejection of signals received with antenna **268** than with the standard transceiver design. Additionally, less power output of the power amplifier **292** of the transmitter section **302** is required since the amplifier is driving a low pass filter having a one-half decibel loss versus the three decibel loss of the bandpass filter **198** of the standard design. Further, each amplifier **270**, **280** and **292** may be selectively activated with enable signals **304**, **306** or **308**, respectively, such that noise will not be inadvertently interfere with the activated amplifier or amplifiers.

Referring now to FIG. 9, multiple access points utilizing communication transceivers of the present invention are shown. In FIG. 9, a wireless communication operation **310** between dual access points **312** and **314** is shown. Such an operation **310** maybe substantially similar to communications between access points **48** and **56** of FIG. 2 showing a wireless communications link **86** between the two access points. **R1** may represent one-half of the maximum operating distance between two given access points utilizing standard architecture transceivers such as shown in FIG. 6. Thus, radius **R1** may be considered to represent the given operating radius attributed to an individual access point for a standard architecture transceiver. Radius **R2** may be considered to represent the given operating radius attributed to an individual access point when a transceiver having the diversity architecture of the present invention, such as transceiver **224** of FIG. 7 or transceiver **264** of FIG. 8.

As illustrated in FIG. 9, access points **312** and **314** may be set apart a given distance wherein the operating radii **R1** of the access points do not overlap when utilizing standard transceiver architecture, and no wireless communications between access points **312** and **314** may occur. However, because the operating radii **R2** of the access points

do overlap at the distance depicted in FIG. 9, wireless communications between access points **312** and **314** may occur. Thus, as illustrated, the improved transceiver architecture of the present invention provides for an increased operational range of the transceivers for a given maximum  
5 broadcasting power. Maximum broadcasting powers are typically mandated by governmental agencies, therefore the capability of increasing operational range of wireless communications without increasing broadcasting power is highly advantageous.

It is believed that the improved receiver sensitivity for a diversity  
10 architecture transceiver of the present invention and many of its attendant advantages will be understood by the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the components thereof without departing from the scope and spirit of the invention or without sacrificing  
15 all of its material advantages. The form herein before described being merely an explanatory embodiment thereof. It is the intention of the following claims to encompass and include such changes.

## CLAIMS

What is claimed is:

1           1.     A communications transceiver, comprising:  
2           a first antenna connected to a first amplifier;  
3           a second antenna connected to a second amplifier;  
4           an intermediate frequency stage; and  
5           a selector being connected between said first and second amplifiers  
6           and said intermediate frequency stage for selecting operation of the  
7           communications transceiver between said first and second antennas.

1           2.     A communications transceiver as claimed in claim 1,  
2           wherein said first amplifier is an input amplifier for amplifying signals  
3           received by said first antenna.

1           3.     A communications transceiver as claimed in claim 1,  
2           wherein second amplifier is an input amplifier for amplifying signals  
3           received by said second antenna.

1           4.     A communications transceiver as claimed in claim 1,  
2           wherein said second amplifier is an output amplifier for amplifying  
3           signals transmitted by said second antenna.

1           5.     A communications transceiver as claimed in claim 4, further  
2           comprising a third amplifier connected to said second antenna and said  
3           selector for amplifying signals received by said second antenna.

1           6.     A communications transceiver as claimed in claim 5, further  
2 comprising a second selector connected between said second antenna  
3 and said second and third amplifiers for selecting connection of said  
4 second antenna between said second and third amplifiers.

1           7.     A communications transceiver as claimed in claim 1, further  
2 comprising a filter disposed between said selector and said intermediate  
3 frequency stage.

1           8.     A communications transceiver as claimed in claim 7,  
2 wherein said filter is a low-pass filter.

1           9.     A communications transceiver as claimed in claim 1, further  
2 comprising a filter disposed between said first antenna and said first  
3 amplifier.

1           10.    A communications transceiver as claimed in claim 9,  
2 wherein said filter is a bandpass filter.

1           11.    A communications transceiver as claimed in claim 1, further  
2 comprising a filter disposed between said second antenna and said  
3 second amplifier.

1           12.    A communications transceiver as claimed in claim 11,  
2 wherein said filter is a bandpass filter.

1           13.    A communications transceiver as claimed in claim 6, further  
2 comprising a filter disposed between said second antenna and said  
3 second selector.

1           14. A communications transceiver as claimed in claim 1, said  
2 first amplifier including an enable control for selectively activating said  
3 first amplifier.

1           15. A communications transceiver as claimed in claim 1, said  
2 second amplifier including an enable control for selectively activating  
3 said second amplifier.

1           16. A communications transceiver as claimed in claim 5, said  
2 third amplifier including an enable control for selectively activating said  
3 third amplifier.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153  
154  
155  
156  
157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175  
176  
177  
178  
179  
180  
181  
182  
183  
184  
185  
186  
187  
188  
189  
190  
191  
192  
193  
194  
195  
196  
197  
198  
199  
200  
201  
202  
203  
204  
205  
206  
207  
208  
209  
210  
211  
212  
213  
214  
215  
216  
217  
218  
219  
220  
221  
222  
223  
224  
225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242  
243  
244  
245  
246  
247  
248  
249  
250  
251  
252  
253  
254  
255  
256  
257  
258  
259  
260  
261  
262  
263  
264  
265  
266  
267  
268  
269  
270  
271  
272  
273  
274  
275  
276  
277  
278  
279  
280  
281  
282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312  
313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343  
344  
345  
346  
347  
348  
349  
350  
351  
352  
353  
354  
355  
356  
357  
358  
359  
360  
361  
362  
363  
364  
365  
366  
367  
368  
369  
370  
371  
372  
373  
374  
375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413  
414  
415  
416  
417  
418  
419  
420  
421  
422  
423  
424  
425  
426  
427  
428  
429  
430  
431  
432  
433  
434  
435  
436  
437  
438  
439  
440  
441  
442  
443  
444  
445  
446  
447  
448  
449  
450  
451  
452  
453  
454  
455  
456  
457  
458  
459  
460  
461  
462  
463  
464  
465  
466  
467  
468  
469  
470  
471  
472  
473  
474  
475  
476  
477  
478  
479  
480  
481  
482  
483  
484  
485  
486  
487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501  
502  
503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543  
544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569  
570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595  
596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631  
632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668  
669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696  
697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717  
718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862  
863  
864  
865  
866  
867  
868  
869  
870  
871  
872  
873  
874  
875  
876  
877  
878  
879  
880  
881  
882  
883  
884  
885  
886  
887  
888  
889  
890  
891  
892  
893  
894  
895  
896  
897  
898  
899  
900  
901  
902  
903  
904  
905  
906  
907  
908  
909  
910  
911  
912  
913  
914  
915  
916  
917  
918  
919  
920  
921  
922  
923  
924  
925  
926  
927  
928  
929  
930  
931  
932  
933  
934  
935  
936  
937  
938  
939  
940  
941  
942  
943  
944  
945  
946  
947  
948  
949  
950  
951  
952  
953  
954  
955  
956  
957  
958  
959  
960  
961  
962  
963  
964  
965  
966  
967  
968  
969  
970  
971  
972  
973  
974  
975  
976  
977  
978  
979  
980  
981  
982  
983  
984  
985  
986  
987  
988  
989  
990  
991  
992  
993  
994  
995  
996  
997  
998  
999  
1000

1        17. A communications transceiver, comprising:  
2        a first antenna connected to a first amplifier;  
3        a second antenna;  
4        an intermediate frequency stage connected to a second amplifier;  
5        and  
6        a selector disposed between said first amplifier and said  
7        intermediate frequency stage and between said second antenna and said  
8        second amplifier for selecting operation of the communications  
9        transceiver between said first and second antennas.

1        18. A communications transceiver as claimed in claim 17,  
2        wherein said first amplifier includes a feedback loop for altering the  
3        operational characteristics of said first amplifier.

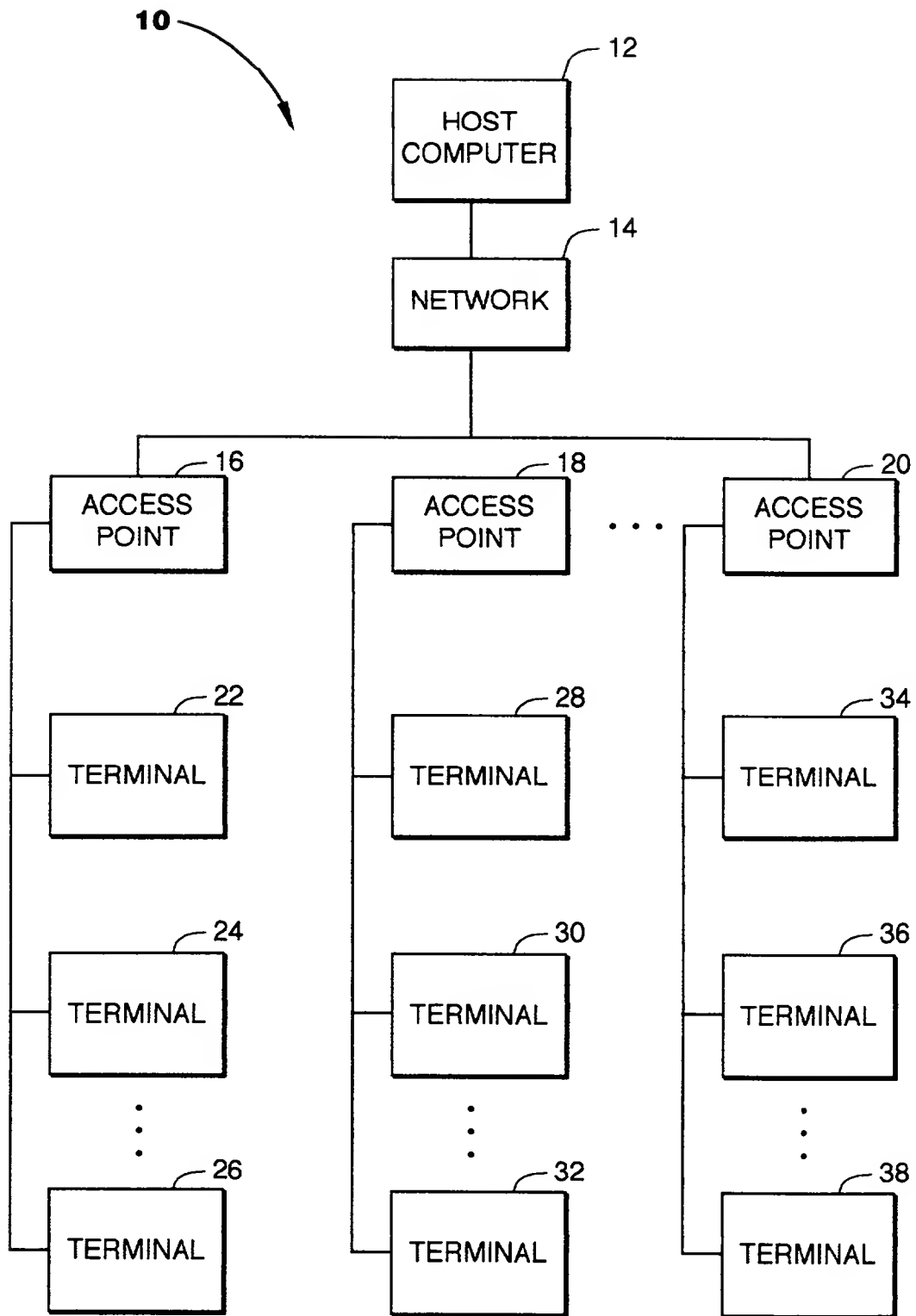
1        19. A communications transceiver as claimed in claim 18,  
2        wherein said feedback loop includes a switch for selectively activating  
3        said feedback loop.

1        20. A communications transceiver as claimed in claim 18,  
2        wherein said feedback loop is a closed loop.

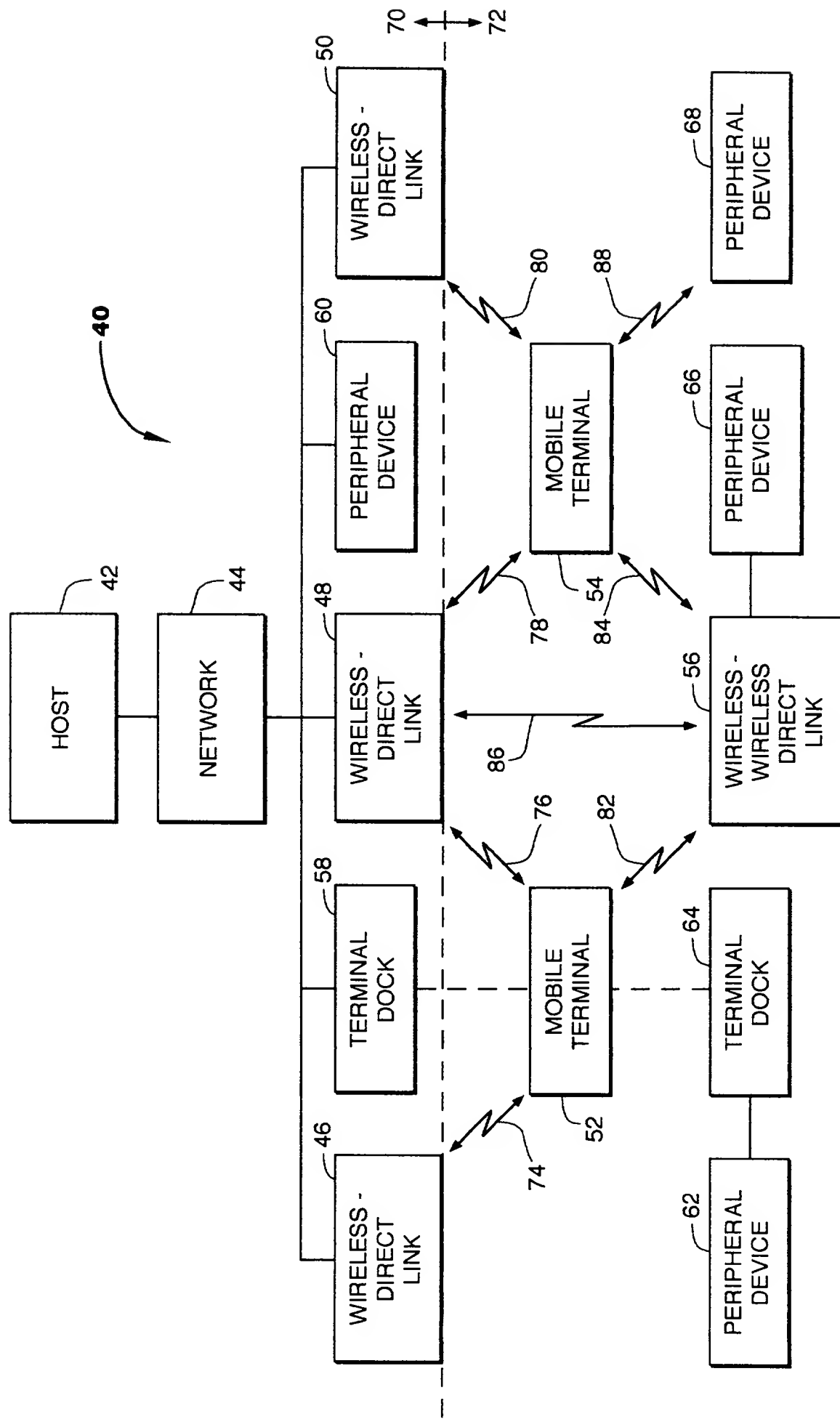
## IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER HAVING DIVERSITY ARCHITECTURE

### 5                    ABSTRACT OF THE DISCLOSURE

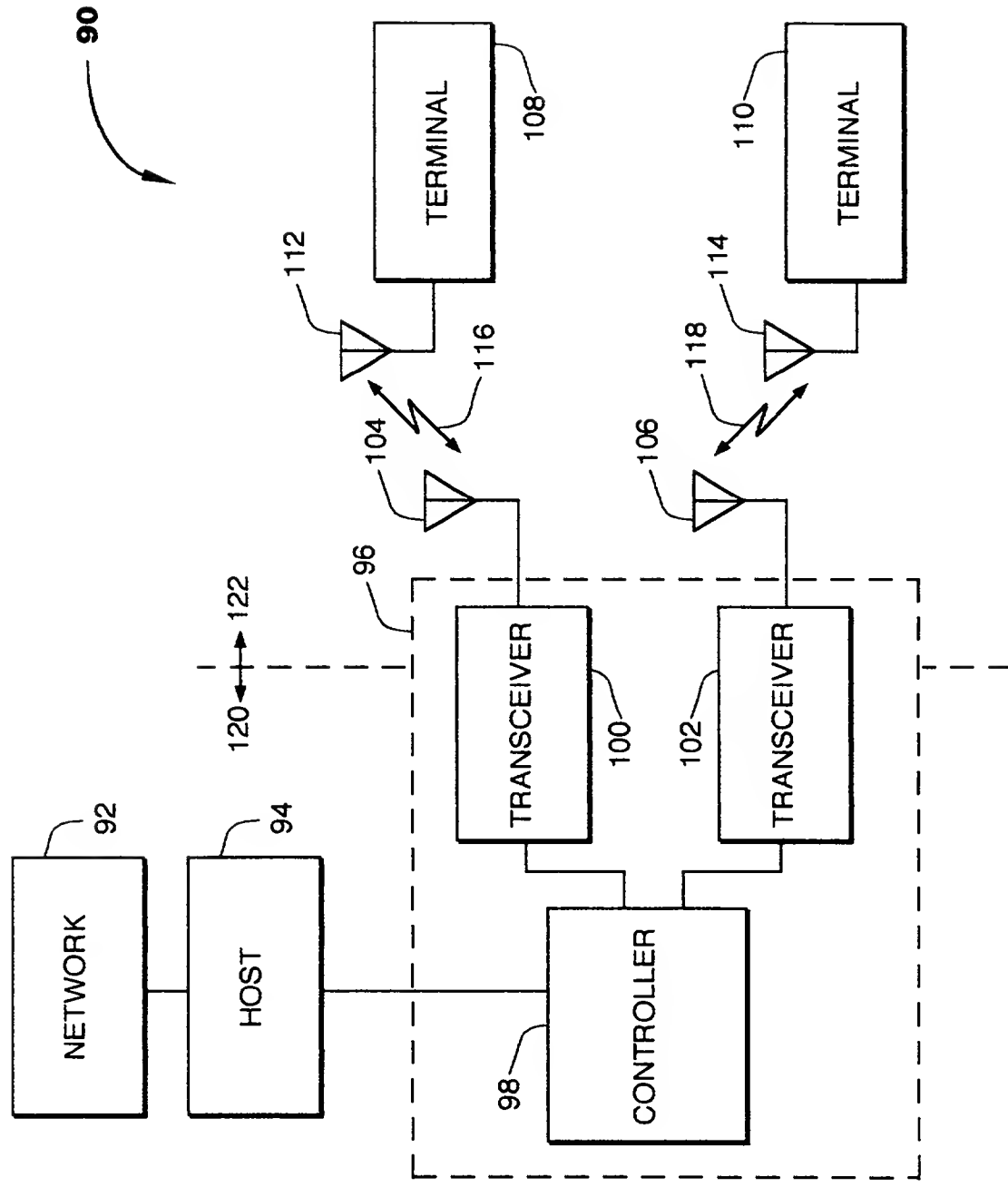
A communications transceiver incorporating diversity architecture for utilization with a wireless communications network and having improved receiver sensitivity is disclosed. In a first embodiment of the invention, the communications transceiver comprises a pair of antennas  
10 connected to a pair of amplifiers and a selector connected between the amplifiers and the intermediate frequency stage of the transceiver for providing selective operation of the communications transceiver with either antenna of the pair of antennas. In a second embodiment of the invention, the communications transceiver comprises a pair of antennas,  
15 a pair of amplifiers and a selector disposed between the first amplifier and the intermediate frequency stage of the transceiver and between the second antenna and the second amplifier for providing selective operation of the communications transceiver with either of the antennas. The architecture of the communications transceiver of the present  
20 invention provides improved receiver selectivity, improved noise figure, improved signal-to-noise ration, and improved power output.



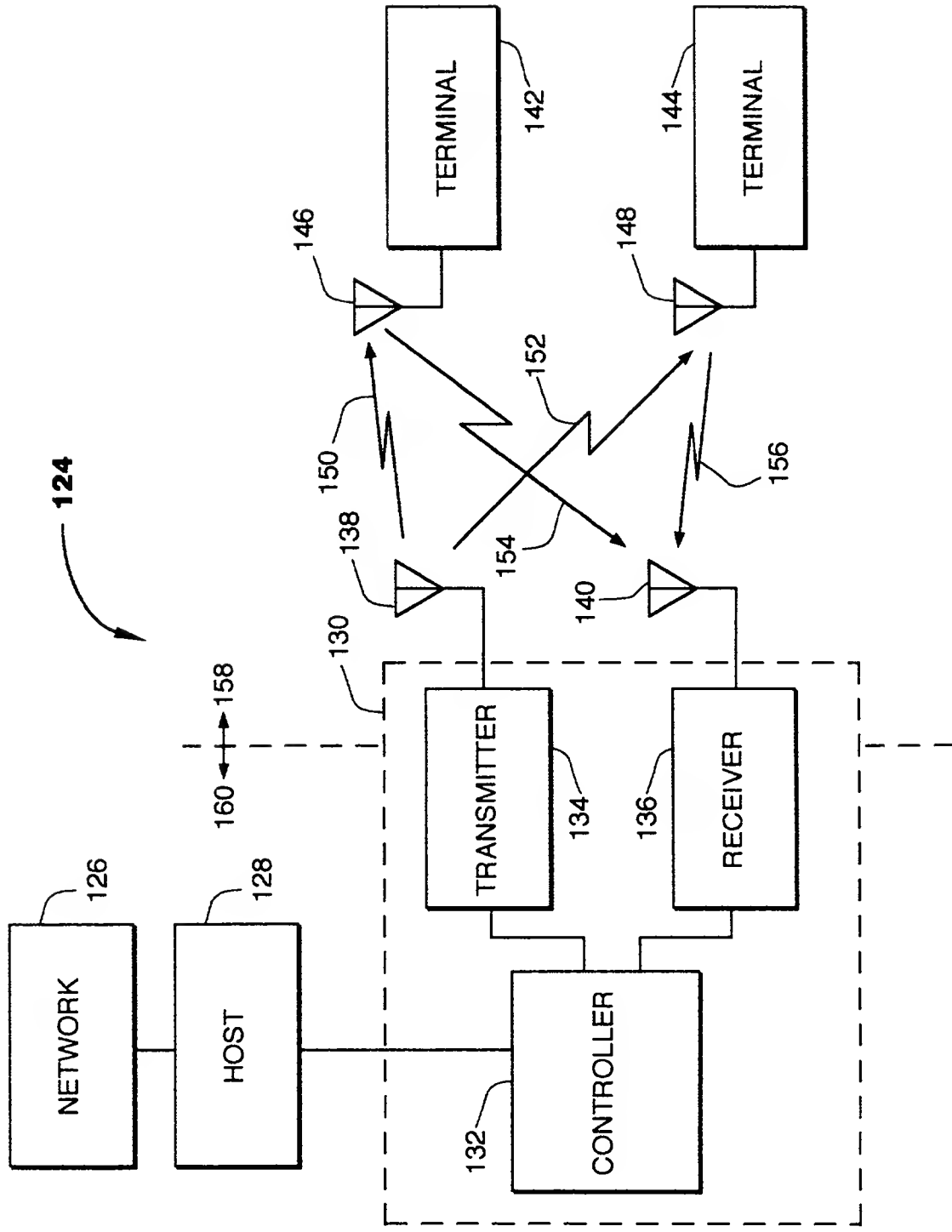
**FIG. 1**



**FIG. 2**



**FIG. 3**



**FIG. 4**

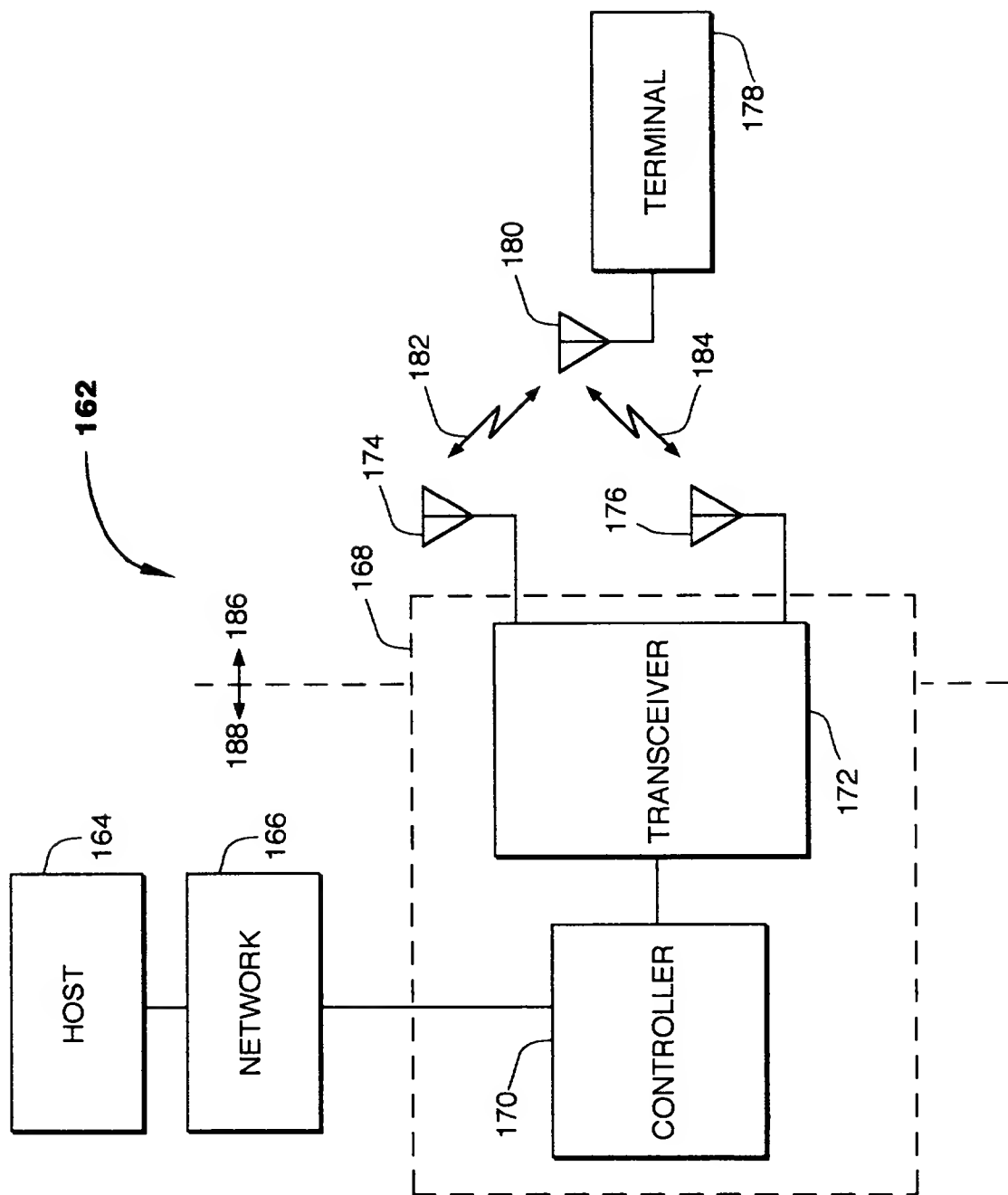


FIG. 5

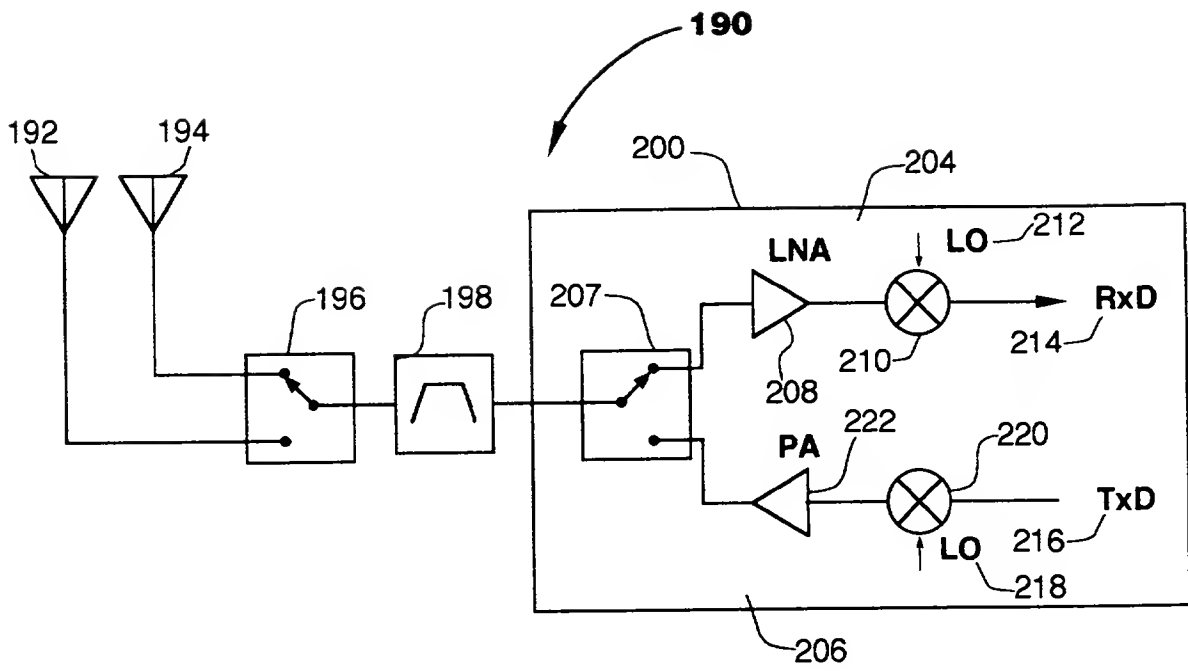


FIG. 6

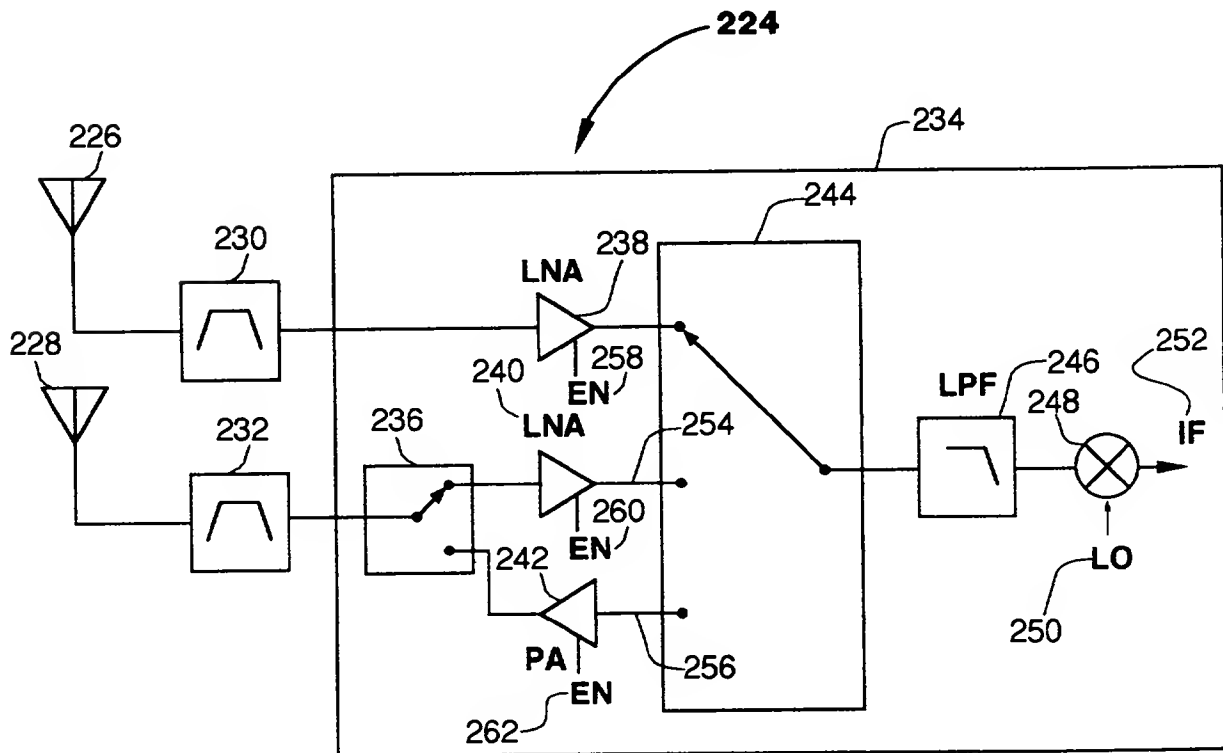


FIG. 7

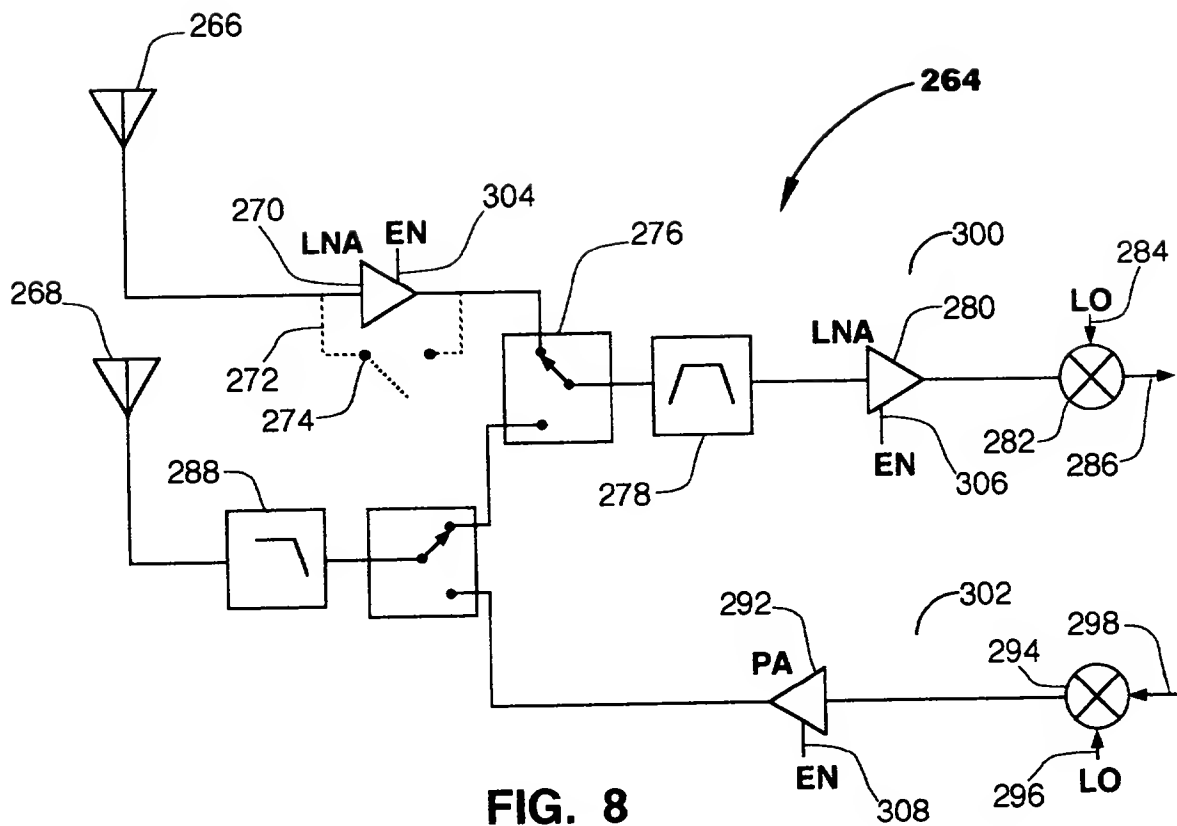


FIG. 8

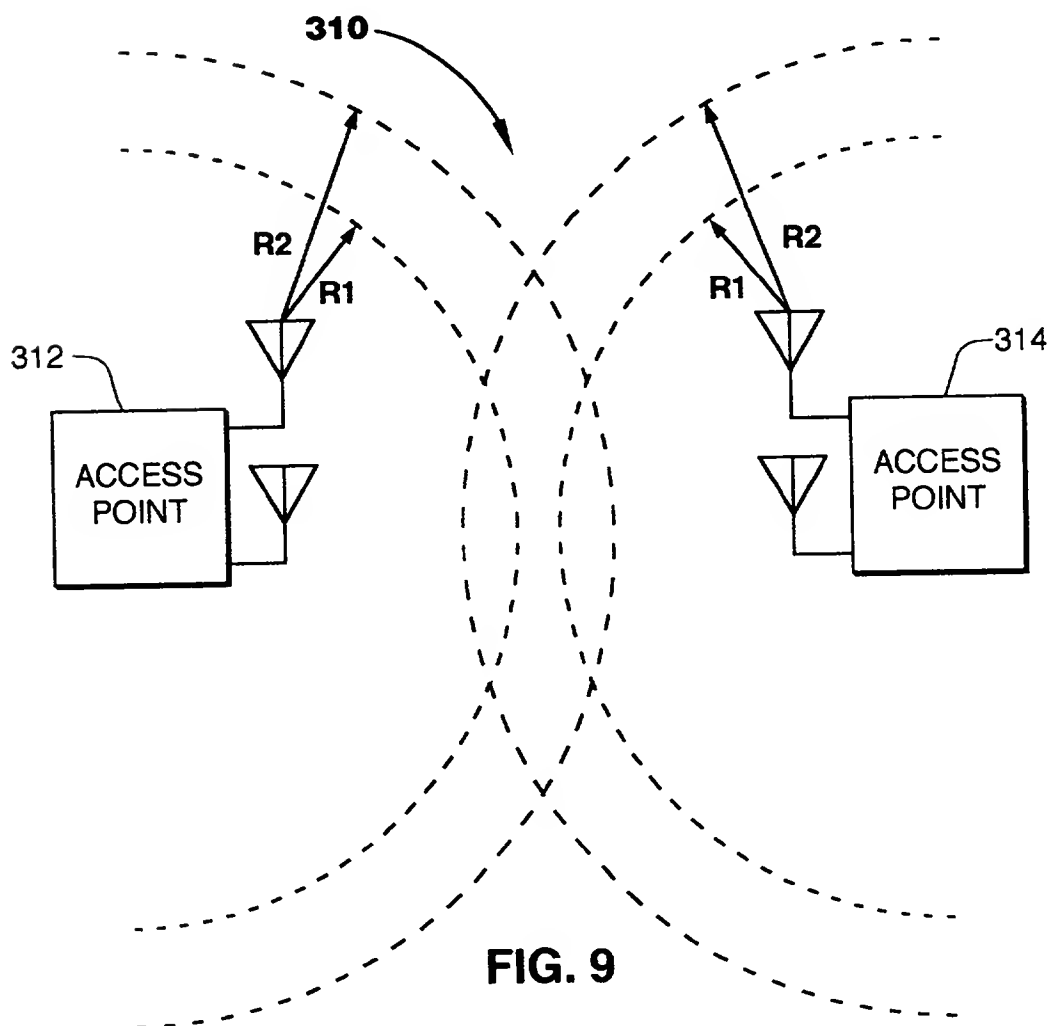


FIG. 9

**COMBINED DECLARATION AND POWER OF  
ATTORNEY IN A NONPROVISIONAL PATENT APPLICATION**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; that I believe that I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER  
HAVING DIVERSITY ARCHITECTURE**

described and claimed in the specification as filed on \_\_\_\_\_ as U.S. Serial N<sup>o</sup> \_\_\_\_\_, via United States Postal Service Express Mail Label N<sup>o</sup> EL 025 200 855 US.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 C.F.R. §1.56(a).

**CLAIM FOR BENEFIT OF EARLIER U.S.  
APPLICATIONS UNDER 35 U.S.C. §120**

I hereby claim the benefit under 35 U.S.C. §120 of any United States applications that are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in those prior applications in the manner provided by the first paragraph of 35 U.S.C. §112, we acknowledge the duty to disclose information that is material as defined 37 C.F.R. §1.56(a), which occurred between the filing date of the prior applications and the filing date of this application.

USSN

Filing Date

Inventor(s)

Status

N/A

**CLAIM FOR BENEFIT OF EARLIER  
APPLICATIONS UNDER 35 U.S.C. §119(e)**

I hereby claim priority benefits under 35 U.S.C. §119(e), of any applications for patent or inventor's certificate listed below:

<u>USPSN</u>	<u>Filing Date</u>	<u>Inventor(s)</u>	<u>Status</u>
60/044,249	04/23/97	Wilz	Privisional

**CLAIM FOR BENEFIT OF EARLIER PCT  
APPLICATIONS UNDER 35 U.S.C. §119**

I hereby claim foreign priority benefits under 35 U.S.C. §119, of any foreign applications for patent or inventor's certificate listed below:

<u>PCT Application N<sup>o</sup></u>	<u>Filing Date</u>	<u>Country</u>
N/A		

I hereby appoint as my attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business with the Patent and Trademark Office connected therewith:

William M. Wesley	Reg. N <sup>o</sup> 26,521
Herbert D. Hart, III	Reg. N <sup>o</sup> 30,063
Robert W. Fieseler	Reg. N <sup>o</sup> 31,826
George P. McAndrews	Reg. N <sup>o</sup> 22,760
John J. Held	Reg. N <sup>o</sup> 21,061
Timothy J. Malloy	Reg. N <sup>o</sup> 25,600
J. Michael Jarvis	Reg. N <sup>o</sup> 27,341
Robert C. Ryan	Reg. N <sup>o</sup> 29,343
Gregory J. Vogler	Reg. N <sup>o</sup> 31,313
Donald J. Pochopien	Reg. N <sup>o</sup> 32,167
Jean Dudek Kuelper	Reg. N <sup>o</sup> 30,171
Steven J. Hampton	Reg. N <sup>o</sup> 33,707
Alejandro Menchaco	Reg. N <sup>o</sup> 34,389
Priscilla F. Gallagher	Reg. N <sup>o</sup> 32,223
Robert B. Polit	Reg. N <sup>o</sup> 33,993
George F. Wheeler	Reg. N <sup>o</sup> 28,766
D. David Hill	Reg. N <sup>o</sup> 35,543
Christopher C. Winslade	Reg. N <sup>o</sup> 36,308
Thomas J. Wimbiscus	Reg. N <sup>o</sup> 36,059
John S. Artz	Reg. N <sup>o</sup> 36,431
Gregory C. Schodde	Reg. N <sup>o</sup> 36,668



## DECLARATION

I hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

The Attorney of Record herein is hereby authorized to insert the Serial Number and filing date when received from the United States Patent and Trademark Office.

Dated: \_\_\_\_\_

FULL NAME OF INVENTOR:

\_\_\_\_\_  
**LEO JOHN WILZ**

A Citizen of the United States  
1718 Hamer Drive, N.W.  
Cedar Rapids, IA 52405  
Linn County